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A PRACTICAL MODERN TREATISE ON  
GEOMETRICAL OPTICS.

*The Principles and Methods of Geometrical Optics, especially as Applied to the Theory of Optical Instruments.* By Prof. J. P. C. Southall. Pp. xxiii+626. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1910.) Price 25s. net.

IT is safe to assert that this volume will at no very distant date be in the hands of every serious English-speaking student of geometrical optics. We know of no other work in the English language in which the attempt has been made to give a thorough and systematic account of the fundamental principles and methods of geometrical optics, so far as these are necessary for dealing with the problems of the optical workshop. There are in existence several conscientious text-books of deservedly good repute, which, as Silvanus Thompson has said, serve—rather, perhaps, served—admirably to get up the subject for the tripos, and are dotted with ingenious and fascinating problems, e.g. to find the equation of the bright curve seen on the spokes of a bicycle wheel rotated rapidly in the sun; but these leave untouched a vast number of questions of fundamental importance to the practical optician. More recently Dennis Taylor, whose practical knowledge and experience are unquestionably of the highest order, has attempted to provide a handbook which would assist in practical lens calculations; unfortunately the methods employed are unnecessarily cumbrous, while, as originally published, the book was marred by accidental, but serious, errors. The need of such a work in English as the present has been often stated, and with sufficient emphasis; an Englishman may be pardoned for regretting that it now only reaches him from the other side of the Atlantic.

To the reader who is familiar with Czapski's "Grundzüge der Theorie der optischen Instrumente nach Abbe" and with "Die Theorie der optischen Instrumente" (vol. i.), published by the members of the Zeiss firm, a glance through the pages of Prof. Southall's volume will be sufficient to show how largely he is indebted to these works, both as regards method of treatment and detail; a debt, indeed, which he warmly acknowledges. The author exhibits, further, a wide acquaintance with recent French and German optical literature, to which most useful references are given throughout the work. But the book is no mere translation or compilation. It is a thorough, logical, comprehensive account of the fundamental principles of geometrical optics and of the theory of optical instruments, written by one who not only has an exceptionally extensive knowledge of the work done by others, but has also an unusually complete grasp of his subject and of the essentials necessary to its clear presentation.

In a work on geometrical optics nomenclature and notation are both of the greatest importance, and to these special attention has been given. The results are, we venture to think, on the whole conspicuously

successful. The notation adopted is suggestive, clearly stated, agrees in most important respects with established usage, and is carefully held to throughout the work. Great assistance is given by an index and explanation at the end of the book of the symbols used. The use of thick face type to indicate points on the chief ray of a bundle is especially convenient. As regards nomenclature, it may be noted that the term pencil of rays is confined to rays in one plane, the word bundle being employed for a system of concurrent rays in space; the term "chief ray," Sylvanus Thompson's translation of "Hauptstrahl," has been adopted as denoting especially the ray which passes through the centre of the aperture-stop in an optical instrument, or, in the object space, through the centre of the entrance pupil; and the words "Eintrittsluke," "Austrittsluke," are well rendered by the terms "entrance-port," "exit-port," denoting the virtual apertures or windows which bound the field of view in the object space and image space respectively.

The general discussion of refraction through a prism or prism system is given early in the book. In the treatment much use is made of the work of Burmester. This is followed by chapters on the reflexion and refraction of paraxial rays at spherical surfaces and their refraction through thin lenses. The discussion of the relations between object and image in these simple cases leads up to the important chapter on Abbe's theory of optical imagery, of which a full account is given in Czapski's volume above referred to. In Abbe's theory the assumption is made of a point-to-point correspondence, by means of rectilinear rays, between object and image, and from this, without any hypothesis as to the image-forming optical instrument, the fundamental laws expressing the relationship between object and image are deduced, whether for a simple or a compound optical system. In his clear and full treatment of this part of his subject Prof. Southall makes great use of geometrical methods, which are, of course, specially appropriate. It is possible that some practical opticians who are unacquainted with the elements of modern geometry may find this a deterrent, but the amount of knowledge necessary is so slight and so easily acquired that it would be unreasonable to give such an objection serious consideration. The results are applied in the succeeding chapter to the Gauss system of centred surfaces.

The general discussion follows of the exact methods of tracing the path of a ray through a system of centred surfaces when the angles of incidence are not necessarily small. The computation formulæ given are those of Kerber and von Seidel, and some illustrations of their use are afforded. In the subsequent account of the approximate theory of the spherical aberrations the author has followed somewhat closely the plan adopted by König and von Rohr in the chapter devoted to this subject in "Die Theorie der optischen Instrumente." Thus the spherical aberration on the axis, distortion, astigmatism, curvature of field, and coma, are separately considered, while in conclusion a somewhat modified presentation is given of von Seidel's theory, of which an excellent account is provided in Silvanus Thompson's transla-

tion of Lummer's "Photographic Optics." A separate chapter deals with the reflexion and refraction of astigmatic bundles of rays, and in a further chapter the colour aberrations are discussed.

The last chapter, which is of considerable importance, reproduces Abbe's theory of the action of the "stops" in an optical instrument, and deals generally with questions depending on the aperture and the field of view.

The preceding notes will sufficiently indicate the scope of the book. It is confined to the discussion of general optical principles, and methods of calculation applicable to optical instruments, and does not actually deal with the application of these methods. It thus covers practically the same ground as vol. i. of "Die Theorie der optischen Instrumente" already referred to. The subtitle of that volume, "Image formation in optical instruments from the standpoint of geometrical optics," is, indeed, excellently descriptive of the present work. The range is sufficiently extensive, and it would hardly be possible, within the limits of a single volume, to include in addition the theory of lens design, or the application of the general principles to special types of optical instruments. On the other hand, a volume, or rather volumes, dealing with these applications are urgently needed. It is to be feared that there are many practical opticians in this country to whom it may appear that this work offers little of immediate practical importance, and to whom it would only be possible to work back, so to speak, to the present volume from one dealing with its immediate application to, say, the telescope or the photographic lens. It is earnestly to be hoped that Prof. Southall may be persuaded to provide them with the opportunity. There are few who have his equipment for the task, and the need is universally recognised. There can be no question that by the issue of the present volume Prof. Southall has rendered a great service to American and to English opticians.

It may be added that the general get-up of the book is excellent; the type is clear, and the figures well drawn. Some of the figures, however, would have been much improved if they had been reproduced on a somewhat larger scale.

#### MANCHURIA, KOREA, AND RUSSIAN TURKESTAN.

*The Face of Manchuria, Korea, and Russian Turkestan.* Written and illustrated by E. G. Kemp. Pp. xv+248+xxiv plates. (London: Chatto and Windus, 1910.) Price 7s. 6d. net.

THE facilities afforded by extended railway communication to remote regions of eastern Asia have rendered it possible for the leisured tourist to travel safely, and with comparative comfort, from Russia to the seaboard of Asia on the east in a direct line traversing a vast area, a great part of which still remains unexplored, especially in Korea and Russian Turkestan, although excellent work has been done within the last decade by intrepid travellers in crossing the deserts, and surveying the mountain chains in which this part of Asia abounds. Judging from

NO. 2155, VOL. 85]

previous work, the author, as an expert tourist, has had some useful training, and has not wholly confined descriptions of the route to the face of things, but has invested the work with unusual interest by historical and other notes concerning the races inhabiting the countries traversed. Four months covered the outward and return journeys, following the lines of the Transsiberian Railway, and onward by connecting lines to Korea, and home again.

The result is the volume under review, which forms an attractive addition to tourist literature, a picturesque guide-book so agreeably written as to captivate the reader who has neither time nor opportunity to follow in the author's footsteps. The historical notes are discriminating and sufficient for the purpose, while the accounts of various regions and races inhabiting them, their religion, social condition, &c., are not without interest. The political outlook created by the new alliance of Russia and Japan is painted in sombre colours. The Japanese determined by force, if necessary, to coerce the Chinese into throwing Manchuria open to Japanese colonisation, and the attitude of China to resist advances. On the other hand, there is Russia's demand to construct and control a railway direct from Irkutsk to Peking, and to prevent the Chinese running a line into Mongolia.

The position created for China is therefore not without the gravest peril, and in the future may lead to serious complications in view of China's progress as a military Power. The author acknowledges indebtedness for trustworthy information supplied along the route. The line into Manchuria joins the Transsiberian Railway with the continuation of the line to Mukden and Peking, enabling the traveller to reach the Chinese capital, starting from London, in about seventeen days. The Japanese appear to have been forestalled in their desire to colonise Manchuria, as the country is being rapidly overrun by Chinese immigrants, owing to its great fertility, and affording an excellent home to the settlers, who are more prosperous than elsewhere in the empire.

The first section of railway to Kharbin is under Russian control, having soldiers posted at intervals all along the line. Half-way from Kharbin to Mukden it becomes Japanese, having military officers on board the trains. The author's brief historical note on Manchu history may be rendered all the more interesting by a perusal of Mr. Meadows's "History of the Manchus." It goes back to the eleventh century B.C., and is full of adventure, enterprise, and war up to 1644, when the Manchus conquered and founded the present dynasty as rulers of China, when they settled down, adopting Chinese methods of government.

Mukden, the Manchu capital, a picturesque and famous old city, is visited and described. It has fallen into decay, although not without signs of renewed life by the transforming influence of the West. The old palace museum contains perhaps the finest collection of ancient Chinese bronzes and porcelain that exists. Some account is given of the Boxer rising and ravages. The hospital of the missions was wrecked, but has been rebuilt, and we are pleased to note that the Viceroy has promised to contribute 480*l.* annually in support of this beneficent institution. The